Exhibit 2

Further Information

Additional information on the topic of image capture devices is available from the following sources.

Broadcast Engineering magazine is a monthly periodical dealing with television and radio technology. The magazine, published in Overland Park, KS, is free to qualified subscribers.

The Society of Motion Picture and Television Engineers (SMPTE) publishes a monthly *Journal*, and holds an annual technical conference in February and a convention in the Fall. The SMPTE is headquartered in White Plains, NY.

The Society of Broadcast Engineers (SBE) holds technical conferences throughout the year. The SBE is located in Indianapolis, IN.

The National Association of Broadcasters (NAB) holds an annual engineering conference and trade show in the Spring. The NAB is headquartered in Washington, D.C.

5.6 CRT Devices and Displays

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5.6.1 Introduction

The cathode ray tube (CRT) is the dominant display technology for a wide range of applications—both consumer and professional.[4] As the requirements for greater resolution and color purity have increased, improvements have also been made in the design and manufacture of CRT devices and signal-driving circuits. Improvements to the basic monochrome and/or color CRT have been pushed within the last 10 years by the explosion of the personal computer industry and the increased resolution demanded by end users. Display size has also been a key element in CRT development. Consumer interest in large-screen home television has been strong within the last decade, and the roll-out of high-definition television has accelerated this trend.

5.6.2 Basic Operating System

The CRT produces visible or ultraviolet radiation by bombardment of a thin layer of phosphor material by an energetic beam of electrons. Nearly all commercial applications involve the use of a sharply focused electron beam directed time sequentially toward relevant locations on the phosphor layer by means of externally controlled electrostatic or electromagnetic fields. In addition, the current in the electron beam can be controlled or modulated in response to an externally applied varying electric signal. A generalized CRT consists of the following elements:

- An electron beam-forming system
- Electron-beam deflecting system (electrostatic or electromagnetic)
- Phosphor screen
- Evacuated envelope

Figure 5.91 shows the basic design of a monochrome CRT. The electron beam is formed in the electron gun, where it is modulated and focused. The beam then travels through the deflection region, where it is directed toward a specific spot or sequence of spots on the phosphor screen. At the phosphor screen the electron beam gives up some of the energy of the electrons in producing light or other radiation, some in generating secondary electrons, and the remainder in producing heat.

[4]This chapter was adapted from: Whitaker, J.C. 1994. *Electronic Displays: Technology, Design and Applications*. McGraw-Hill, New York. Used with permission.

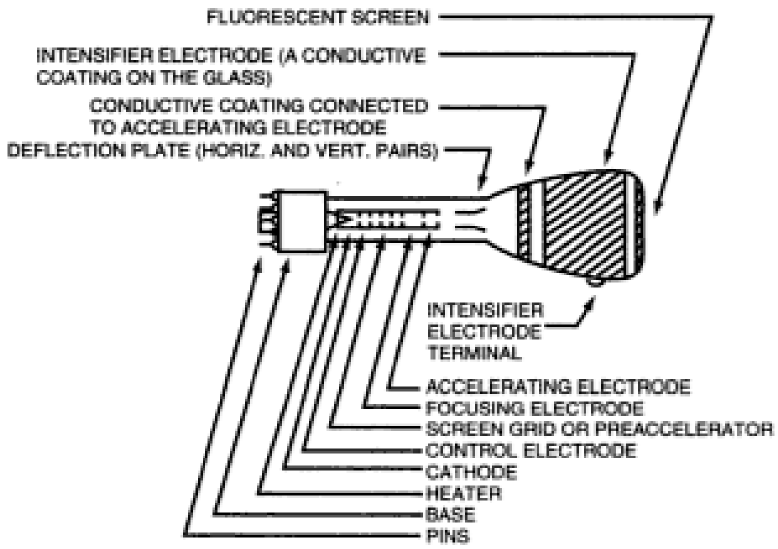

FIGURE 5.91 A generalized schematic of a cathode ray tube using electrostatic deflection.

Classification of CRT Devices

Tubes may be classified in terms of bulb parameters and screen/gun geometry. The principle categories that separate one class of device from another include

- Tube size. Conventionally, tube size is measured as the screen diagonal dimension in rounded inch units. This number is included in tube-type numbers.
- Neck diameter (OD). The gun, yoke, neck hardware, and socketing are affected by this dimension (typically given in millimeter). Common neck sizes are 36.5, 29, and 22.5 mm.
- Deflection angle. This parameter is calculated from the rated full-screen diagonal and glassware drawings, using the yoke reference plane as an assumed center of deflection. Angles in common use include 90, 100, and 110°. Higher deflection angles enable shorter tubes but entail other tradeoffs.
- Other characteristics, including gun type (**delta** or **in-line**), screen structure (stripes or dots) for color CRTs, and flat or curved face plates.

The CRT Envelope

The cathode ray tube envelope consists of the faceplate, bulb, funnel, neck, base press, base, faceplate safety panels, shielding, and potting. (Not all CRTs incorporate each of these components.) The faceplate is the most critical component of the envelope because the display on the phosphor must be viewed through it. Most faceplates are pressed in molds from molten glass and trimmed and annealed before further processing. Some specialized CRTs for photographic recording or flying-spot scanning use optical-quality glass faceplates sealed to the bulb section in such a way as to produce minimum distortion.

To minimize the return scattering of ambient light from the white phosphor, many CRT types use a neutral-gray-tinted faceplate. While the display information is attenuated as it makes a single pass through this glass, ambient light will be attenuated both going in and coming out, thus squaring the attenuation ratio and increasing contrast.

Certain specialized CRTs have faceplates made wholly or partially of fiber optics, which may have extraordinary characteristics, such as high ultraviolet transmission. A fiber optic region in the faceplate permits direct-contact exposure of photographic or other sensitive film without the necessity for external lenses or physical space for optical projection.

The bulb section of the CRT is the transition element necessary to enclose the full deflection volume of the electron beam between the deflection region and the phosphor screen on the faceplate. In most

given by

$$m = \frac{X_2}{X_1}$$

The magnification can be controlled by changing this ratio, which in turn changes the size of the spot. This is one way to control the quality of the focus. Although the actual lens may not be thin, and in general is more complicated than is shown in the figure, the illustration is sufficient to understand the operation of electrostatic focus.

The size of the spot can be controlled by changing the ratio of V_1 to V_2 or of X_2 to X_1 in the previous equations. Because X_1 and X_2 are established by the design of the CRT, the voltage ratio is the parameter available to the circuit designer to control the size or focus of the spot. It is by this means that focusing is achieved for CRTs using electrostatic control.

5.6.3 Color CRT Devices

The shadow-mask CRT is the most common type of color display device. As illustrated in Fig. 5.103, it utilizes a cluster of three electron guns in a wide neck, one gun for each of the colors red, green, and blue. All of the guns are aimed at the same point at the center of the shadow-mask, which is an iron-alloy grid with an array of perforations in triangular arrangement, generally spaced 0.025-in between centers for entertainment television. For high-resolution studio monitor or computer graphic monitor applications, color CRTs with shadow mask aperture spacing of 0.012-in center-to-center or less are readily available. This triangular arrangement of electron guns and shadow-mask apertures is known as the delta-gun configuration. Phosphor dots on the faceplate just beyond the shadow mask are arranged so that after passing through the perforations, the electron beam from each gun can strike only the dots emitting one color.

All three beams are deflected simultaneously by a single large-diameter deflection yoke, which is usually permanently bonded to the CRT envelope by the tube manufacturer. The three phosphors together are designated P-22, individual phosphors of each color being denoted by the numbers P-22R, P-22G, and P-22B. Most color CRTs are constructed with rare-earth-element-activated phosphors, which offer superior color and brightness compared with previously used phosphors.

Because of the close proximity of the phosphor dots to each other and the strict dependence on angle of penetration of the electrons through the apertures, tight control over electron optics must be maintained. Close attention is also paid to shielding the CRT from extraneous ambient magnetic fields and to degaussing of the shield and shadow mask (usually carried out automatically when the equipment is switched on or off).

Even if perfect alignment of the mask and phosphor triads is assumed, the shadow-mask CRT is still subject to certain limitations, mainly in regard to resolution and luminance. The resolution restriction is the result of the necessity for aligning the mask apertures and the phosphor dot triads; the mask aperture size controls the resolution that can be attained by the device.

Electron beam efficiency in a shadow-mask tube is low, relative to a monochrome CRT. Typical beam efficiency is 9%; considering the three beams of the color tube, total efficiency is approximately 27%. By comparison, a monochrome tube may easily achieve 80% electron beam efficiency. This restriction leads to a significant reduction in luminance for a given input power for the shadow-mask CRT.

Parallel-Stripe Color CRT

The parallel-stripe class of CRT, such as the popular **Trinitron**, incorporates fine stripes of red-, green-, and blue-emitting phosphors deposited in continuous lines repetitively across the faceplate, generally in a vertical orientation. (Trinitron is a registered trademark of Sony.) The Trinitron is illustrated in Fig. 5.104. This device, unlike a shadow-mask CRT, uses a single electron gun that emits three electron beams across a diameter perpendicular to the orientation of the phosphor stripes. This type of gun is called the in-line gun. Each beam is directed to the proper color stripe by means of the internal beam-aiming structure and a slitted aperture grille.

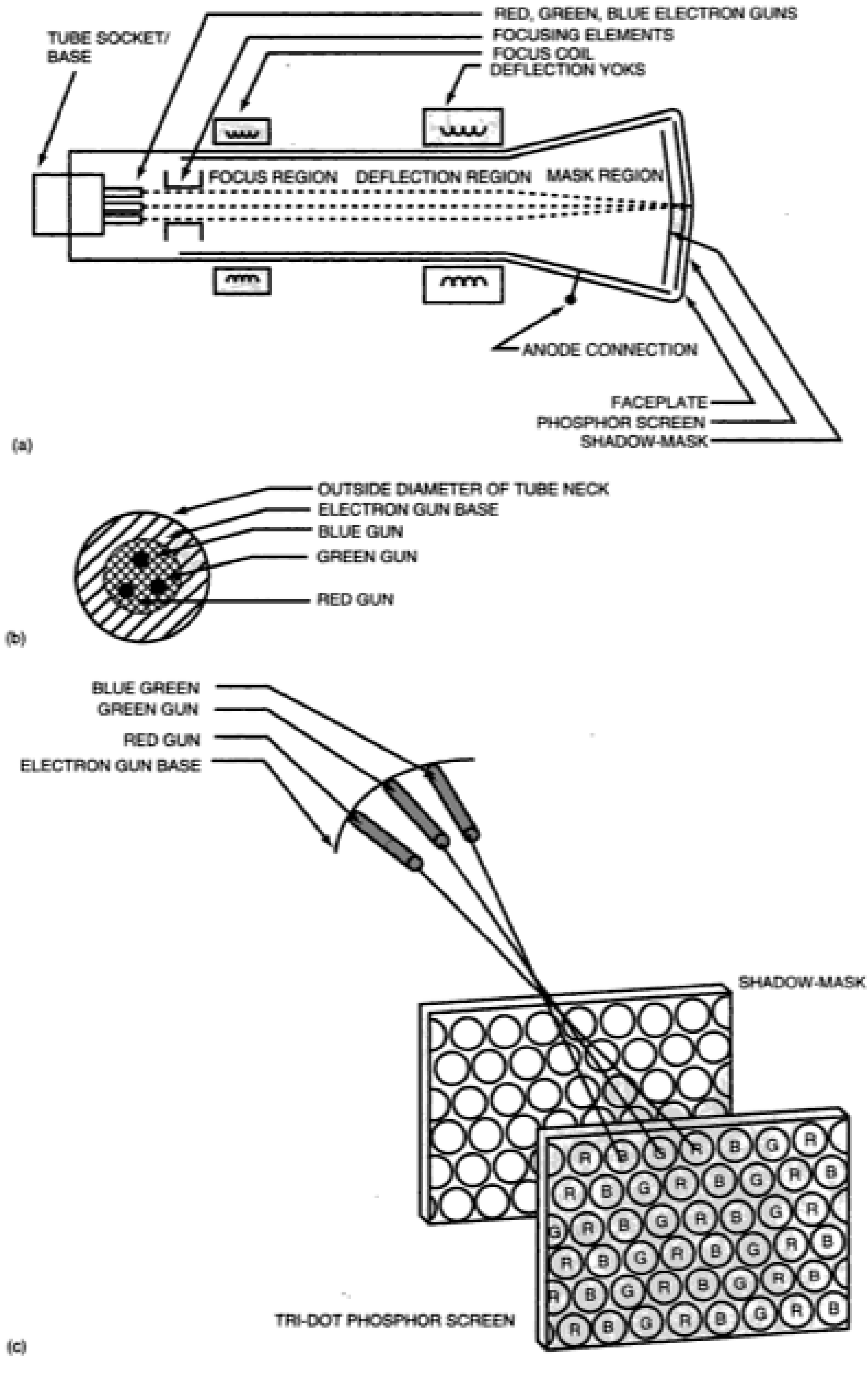

FIGURE 5.103 Basic concept of a shadow-mask color CRT: (a) overall mechanical configuration, (b) delta gun arrangement on the tube base, (c) shadow-mask geometry.

The Trinitron phosphor screen is built in parallel stripes of alternating red, green, and blue elements. A grid structure placed in front of the phosphors, relative to the CRT gun, is used to focus and deflect the beams to the appropriate color stripes. Because the grid spacing and stripe width can be made smaller than the shadow-mask apertures and phosphor dot triplets, higher resolutions may be attained with the Trinitron system.

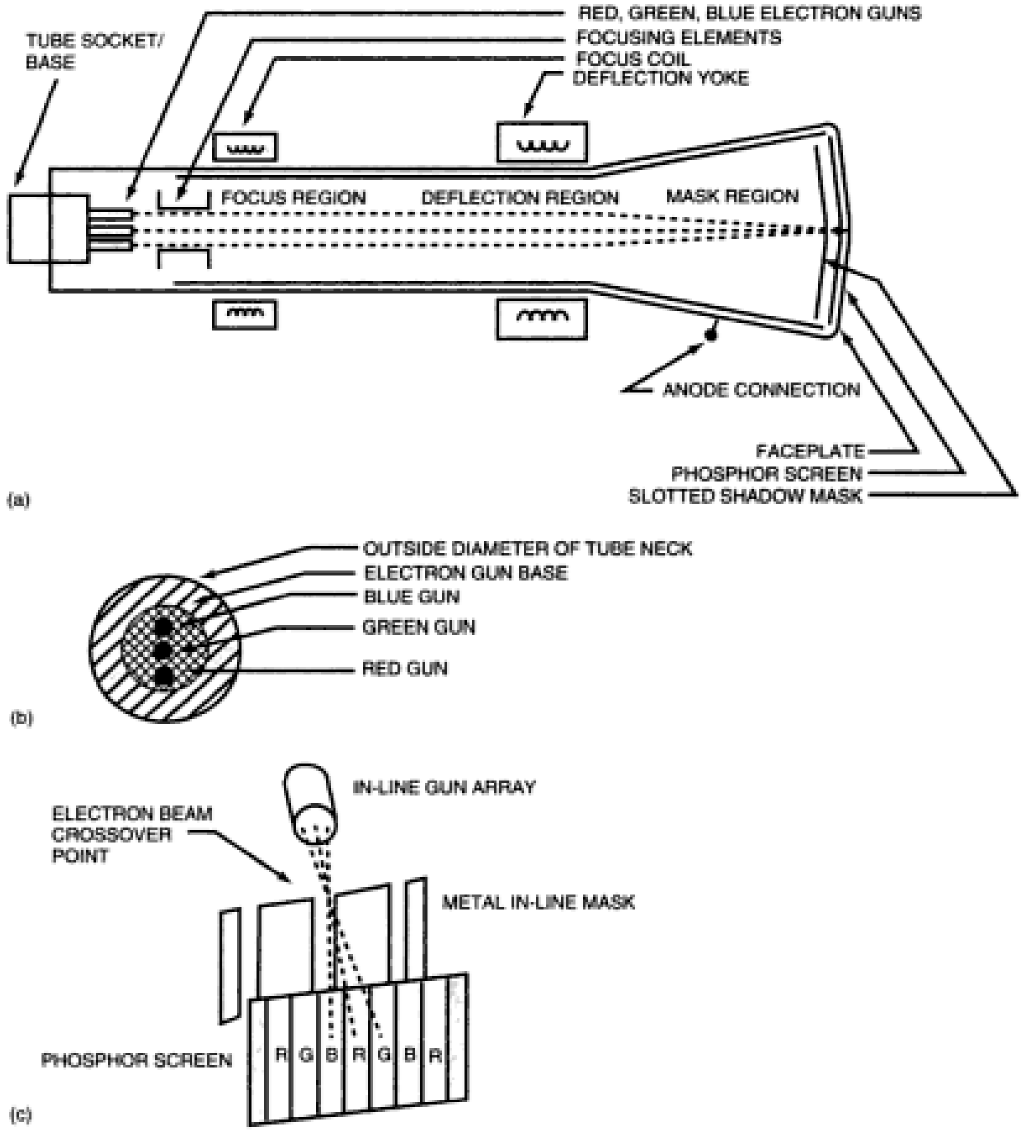

FIGURE 5.104 Basic concept of the Trinitron color CRT: (a) overall mechanical configuration, (b) in-line gun arrangement on the tube base, (c) mask geometry.

Elimination of conventional mask transmission loss, which reduces the electron beam-to-luminance efficiency of the shadow mask tube, permits the Trinitron to operate with significantly greater luminance output for a given beam input power.

The in-line gun is directed through a single lens of large diameter. The tube geometry minimizes beam focus and deflection aberrations, greatly simplifying convergence of the red, green, and blue beams on the phosphor screen.

Basics of Color CRT Design

The shadow-mask CRT is the workhorse of the video display industry. Used in the majority of color video displays since the introduction of color television in the early 1950s, the shadow-mask technique has been refined to yield greater performance and lower manufacturing cost.

Figure 5.105 illustrates the shadow-mask geometry for a tube at face center using in-line guns and a shadow mask of round holes. As an alternative, the shadow-mask may consist of vertical slots, as shown in Fig. 5.106. The three guns and their undeflected beams lie in the horizontal plane. The beams are

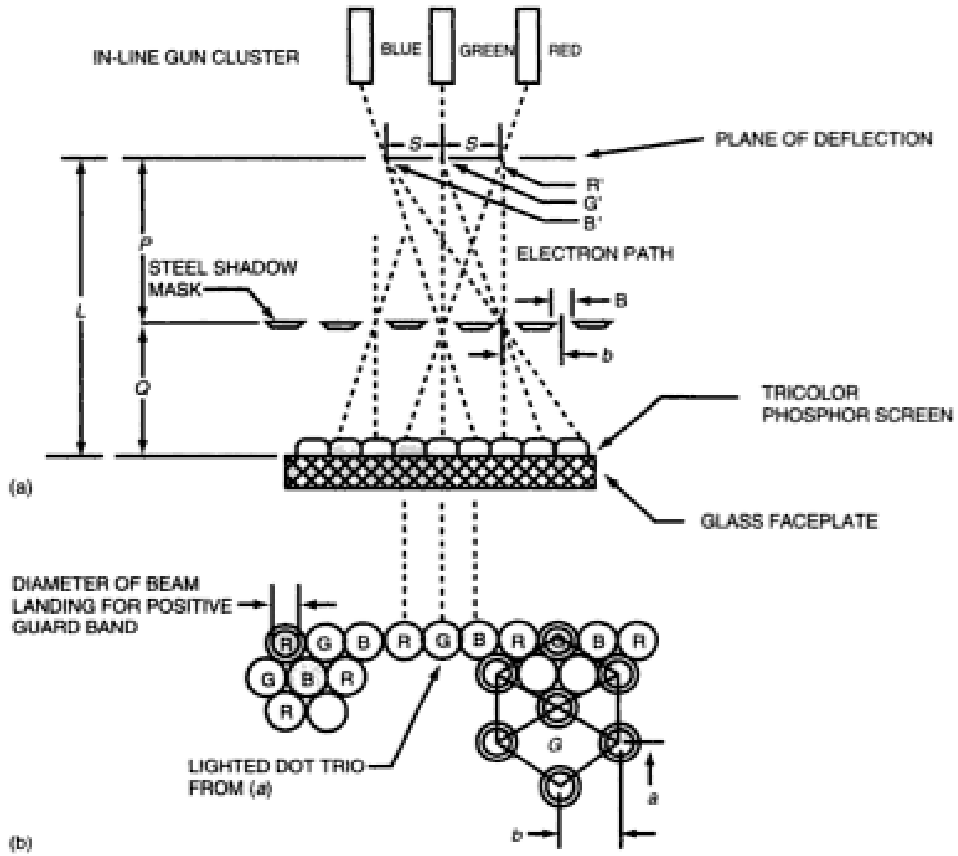

FIGURE 5.105 Shadow-mask CRT using in-line guns and round mask holes: (a) overall tube geometry, (b) detail of phosphor dot layout.

shown converged at the mask surface. The beams may overlap more than one hole and the holes are encountered only as they happen to fall in the scan line. By convention, a beam in the figure is represented by a single straight line projected backward at the incident angle from an aperture to an apparent *center of deflection* located in the *deflection plane*. In Fig. 5.105, the points B′, G′, and R′, lying in the deflection plane, represent such apparent centers of deflections for blue, green, and red beams striking an aperture under study. (These deflection centers move with varying deflection angles.) Extending the rays forward to the facepanel denotes the printing location for the respective colored dots (or stripes) of a tricolor group. Thus, centers of deflection become color centers with a spacing S in the deflection plane. The distance S projects in the ratio Q/P as the dot spacing within the trio. Figure 5.105 also shows how the mask hole horizontal pitch b projects as screen horizontal pitch in the ratio L/P. The same ratio applies for projection of mask vertical pitch a. The Q-space (mask to panel spacing) is optimized to obtain the largest possible theoretical dots without overlap. At panel center, the ideal screen geometry is then a mosaic of equally spaced dots (or stripes).

The stripe screen shown in Fig. 5.106 is used extensively in color CRTs. One variation of this stripe (or line) screen uses a cylindrical faceplate with a vertically tensioned grill shadow-mask without tie bars. Prior to the stripe screen, the standard construction was a tridot screen with a delta gun cluster as shown in Fig. 5.107.

Guard Band

The use of **guard bands** is a common feature for aiding purity in a CRT. The guard band, where the lighted area is smaller than the theoretical tangency condition, may be either *positive* or *negative*. In Fig. 5.105, the leftmost red phosphor exemplifies a positive guard band; the lighted area is smaller than the